WNS Research Tracking - Draft

October 13, 2011

Contents

*Notes – Research projects are listed only once, and in no particular order. It is possible, and very likely, that a particular project may address multiple topics that may not necessarily be reflected within this list.

This document may not be comprehensive; the research projects tracked here have been reported to the U.S. Fish and Wildlife Service WNS Response Team. Projects reported here may be complete or in progress.

Data Management

- **WNS Specimen Tracking System.** Cryan/Everette/Coleman, 2009-2011
  The USGS Fort Collins Science Center will provide technical assistance to the USFWS Region 5 to construct a geospatially oriented data support system for tracking information on WNS specimens (e.g., carcasses, tissues), from collection through analysis.
  Funding Source: US Geologic Survey/US Fish and Wildlife Service

Diagnostics

- **Generation of *G. destructans* specific monoclonal antibodies.** Akiyoshi/Robbins, 2009-2010
  Generation and characterization of monoclonal antibodies against *G destructans* to help develop rapid diagnostic tools.
  Funding Source: US Fish and Wildlife Service

- **miRNA proviles of little brown bat physiological condition and health.** Iwanowicz/King, 2009-2010
  Develop and validate miRNA profiles as suitable biomarkers of little brown bat physiological condition and health. WNS affected and healthy bats will be compared to identify diagnostic profiles that may be used to predict at risk populations prior to the manifestation of clinical evidence of WNS.
  Funding Source: US Fish and Wildlife Service

- **Development of a fluorescent *in situ* hybridization probe for *G. destructans*.** Blehert, 2008
  The probe will be used to positively identify the fungal hyphae observed to invade muzzle, ear, and wing skin of white-nose syndrome affected bats.
  Funding Source: US Fish and Wildlife Service /US Geological Survey

- **Development of enhanced sampling and diagnostic techniques.** Blehert and others, 2011
  Funding Source: US Geological Survey

- **Quantitative PCR for detection of Geomyces destructans.** Drees/Foster/ others
  2011 WNS Symposium Proceedings

Disease Management

Transmission

- **Testing the transmission of WNS from hibernacula to the little brown bat.** Hicks/Darling, 2009
  Determine if little brown bats can get WNS from the cave environment.
  Funding Source: US Fish and Wildlife Service

- **A study of bat-to-bat transmission of WNS**. Blehert, 2009
  Laboratory bat-to-bat infection study.
  Funding Source: US Geological Survey/ US Fish and Wildlife Service/other

- **Summer transmission study**. Okoniewski /Dobony/ others 2010
  Determine whether *G. destructans* persists in the summer and is detectable using various techniques.
  Funding Source: UNK

- **Who will survive? Exploring individual, sex, and species differences in susceptibility and resistance to WNS.** Reeder/Willis/Franck, 2010
  Describe between-species and within-species variation in response to infection with Gd (including the potential lack of infection in some species/individuals, who may be exposed to the fungus [PCR+], but not develop WNS). Determine whether natural selection for traits leading to resistance against Gd/WNS is plausible.
  Funding Source: US Fish and Wildlife Service

- **Species differences and innate immunity to Geomyces colonization in bat populations.** Barton, 2011
  Funding Source: Bat Conservation International

- **Natural history of Geomyces in cave environments: phylogeny, ecosystem activities, natural and anthropogenic transport.** Barton, 2010
  Determine how *G. destructans* may be spread, by both natural and anthropomorphic activities. Develop an understanding of the ecology of *G. destructans* (how it grows in, and likely locations of, *G. destructans* in hibernacula; identify potential refugia for long-term pathogen survival; identify ecological niche within the hibernacula). Develop a library of *Geomyces* species from different hibernacula over a geographic area.
  Funding Source: US Fish and Wildlife Service

- **Fine-scale population structure in Gd: fungal genetics for understanding dispersal, transmission, and effects of WNS.** Foster/others, 2010
  Develop microsatellites, grow and extract fungal DNA, initial testing and screening of microsatellites, and analyze genetic data.
  Funding Source: US Fish and Wildlife Service

- **A systematic study of *Geomyces destructans* within WNS infected hibernacula in New York.** Chaturvedi/ Chaturvedi, 2011
  Define the natural habitat of *G. destructans*, determine if G. destructans grows in the hibernacula environment or exclusively on bats, and study other fungi that share *G. destructans* natural habitats and their roles in fungal survival.
  Funding Source: US Fish and Wildlife Service

- **The effect of sociality on transmission and spread of a multi-host pathogen.**
  Kunz/McCracken/Kilpatrick/Frick/Foster, 2011 - 2016
  Gain a better understanding of how the disease is transmitted at local, regional, and continental scales. Focus on bat social behavior, such as the size of congregating groups and assortment within groups, which are known

to vary both within and between bat species during different seasons. Hypothesize that disease transmission from bat-to-bat and cave-to-cave is affected by temporal and spatial variation in how bat social groups are organized.
Funding Source: National Science Foundation

- **Host community susceptibility to White-nose Syndrome, US (NY, VT, CT, PA).** Langwig. 2011
  Funding Source: Bat Conservation International, Emergency Response Fund

- **Hibernacula microclimate and WNS susceptibility.** Grieneisen, November 2009
  Examine the relationship between hibernacula microclimate and progression of the disease in WNS-affected bats, determine the impact that temperature has on the progression of WNS, and determine the microclimate preferences in WNS-affected and unaffected bats.
  Funding Source: National Speleological Society

- **Investigations of the environmental persistence of Gd**. Blehert and others, 2011
  Funding Source: US Geologic Survey

- **Risk factors associated with white-nose syndrome among hibernating bat colonies.** Wilder/Frick/Langwig/Kunz
  2011 WNS Symposium Proceedings

Treatment/Control/Containment

- **Field testing topical applications of terbinafine for the control of WNS in hibernating bats.** Hicks, 2009-2010
  Test if the anti-fungal terbinafine is effective in controlling the spread of Gd and reduce WNS related mortality.
  Funding Source: UNK

- **Terbinafine dosage and safety in WNS infected Myotis lucifugus: Correlation of survival, drug tissue levels, and toxic effects.** Robbins/Tseng/Reynolds/Beck/Reeder/Lathrop/Helwig/Buckles/Court
  2011 WNS Symposium Proceedings

- **Can artificial thermal refugia reduce mortality associated with WNS?** Craig/Boyles, 2008-2009
  Funding Source: US Fish and Wildlife Service

- **The propagation and decontamination of WNS in the environment.** Barton/Keel, 2009-2011
  Determine methods of killing or inhibiting the growth of *G destructans* and identify a culture media that allows for the more rapid growth of *G. destructans* and other G. spp.
  Funding Source: US Fish and Wildlife Service

- **Investigation of treatment and control strategies of WNS in wild bats.** Blehert/Wright, 2009-2012
  Funding Source: US Geological Survey/Science Support Partnership, US Fish and Wildlife Service

- **Decontamination issues and the natural history of *Geomyces* species in cave environments.** Barton, 2009
  Funding Source: National Speleological Society

- **Identification and evaluation of potential biological control agents towards Geomyces destructans.** Amelon/Knudsen
  Obtain representative isolates of skin bacteria and fungi from selected bat species and screen them for antagonistic activity towards *G. destructans*
  Funding Source: US Fish and Wildlife Service

- **Applied research designed to assist mitigation of White-Nose Syndrome in bats.** Keel/Fischer, 2011
  Refine the use of tissue explants (small samples of live skin from bat patagia) as a model of white-nose syndrome, describe the pathogenesis of white-nose syndrome in bats, and assess the ability of *G. destructans* to infect bat skin of multiple species.
  Funding Source: US Fish and Wildlife Service

- **Modeling a theoretical hibernacula "cleaning" agent.** Janicki
  2011 WNS Symposium Proceedings

Etiology and Epidemiological Research

- **Geographic distribution of the psychrophilic fungus (*Geomyces* sp.).** Blehert/Hicks/Kunz, 2009-2011
  Document the geographic distribution of *G. destructans* in cave sediments.
  Funding Source: US Fish and Wildlife Service/National Speleological Society/US Geological Survey

- **Geomyces destructans genome sequencing project.** Blehert, 2010
  Funding Source: Broad Institute/MIT/additional support from US Geological Survey and National Human Genome Research Institute

- **Molecular epidemiology of G. destructans in U.S. and Europe.** Blehert, 2010
  Funding Source: UNK

- **Development of DNA-based detection techniques capable of differentiating Gd from closely related non-pathogenic Geomyces species.** Lindner/Gargas/Foster/Glaeser, 2011
  Produce the entire genome sequence of 8 *Geomyces* isolates that are closely related to *G. destructans* and develop and test DNA-based detection methods on a variety of sample types, including cave soil samples, bat fecal samples and bat swab samples.
  Funding Source: US Fish and Wildlife Service

- **Characterization of Geomyces spp. fungi closely related to G. destructans.** Blehert/Lindner/ Gargas, 2011
  Funding Source: US Fish and Wildlife Service/US Geologic Survey

- **Understanding the fungal biology of *Geomyces destructans* through comparative analysis of near relatives.** Lindner/Blehert/Drees/Foster/Gargas/Lorch
  2011 WNS Symposium Proceedings

- **Evaluating the pathogenecity of North American and European strains of Gd in cave bats, tree bats, and other mammalian hibernators.** Willis/Blehert/Cryan/Misra/Reeder, 2011
  Determine the susceptibility of North American little brown bats to European isolates of Gd and quantify the severity of physiological and histopathological signs of infection between European and North America isolates of the fungus. Determine the propensity of North American big brown bats and silver-haired bats to become infected with Gd (relative to little brown bats) and quantify the severity of physiological and histopathological signs of infection among these species. Test the dehydration hypothesis by comparing physiological measurements from infected vs. control little brown, silver-haired and big brown bats following infection with Gd.
  Funding Source: US Fish and Wildlife Service/US Geologic Survey

- **A transcriptome approach to study the host-pathogen interactions in WNS.** Akiyoshi/Morrison/Robbins, 2010
  Generate transcriptome profiles from pure Gd cultures (two USA and two European), three uninfected *M. lucifugus* from the USA, and three *M. lucifugus* infected with Gd (USA), compare generated profiles, and analyze changes in gene expression levels on a genome-wide scale with the goal to identify both host and fungal genes associated with the infection process.
  Funding Source: US Fish and Wildlife Service

- **Effects of nonlethal Geomyces destructans infection on reproductive rate and parturition date in cave-hibernating bats, US (IL).** Powers, 2011
  Funding Source: Bat Conservation International, Emergency Response Fund

- **Changes in body composition and immune responses in pre-hibernating and hibernating little brown myotis affected and unaffected by WNS.** Kunz/Reichard, 2009
  Funding Source: US Fish and Wildlife Service

- **Assessing immune competence in bats naturally affected by WNS and in bats artificially infected by the suspected WNS pathogen.** Reeder, 2009
  Funding Source: US Fish and Wildlife Service

- **Histopathological and microbiological evaluation of Chiropteran wing membranes for fungal induced damage.** Buckles, 2009-2010
  Funding Source: US Fish and Wildlife Service

- **Can hibernating bats mount an immune response to skin disease?** Buckles/Kunz, 2011
  Funding source: Bat Conservation International

- **Immune function, body composition, and genetic correlates of bat WNS.** Kunz/Sorensen, 2009-2011
  Describe differences in immune function between affected and unaffected bats.
  Funding Source: US Fish and Wildlife Service

- **Demonstrating a causal link between a *Geomyces* spp. Fungus and White-Nose Syndrome in little brown *Myotis (Myotis lucifugus*).** Blehert, 2009
  Funding Source: Bat Conservation International

- **Measuring cytochine profiles in hibernating myotis lucifigus affected by WNS: assessment of immunocompetence levels in bats affected versus unaffected bats.** Kunz/Moore, 2010
  Funding Source: National Speleological Society

- **Death by starvation: A hypothesis-based investigation of WNS in the little brown myotis.** Kunz, 2008-2010
  Analyze body composition and dietary composition of bats, and the biomass and quality of insects available to little browns during pre-hibernation period.
  Funding Source: National Speleological Society/Bat Conservation International/others

- **The potential role of dietary alpha-linolenic acid in WNS.** Frank/Hicks/Kunz/Rudd
  Funding Source: National Science Foundation

- **Winter energetic of little brown bats with WNS.** Tomasi/Janicki, 2008-2009
  Quantify the torpid metabolic rates of hibernating little brown bats to explore energetic changes associated with WNS
  Funding Source: National Speleological Society/Bat Conservation International/Missouri State

- **Energetic abnormalities of white-nose syndrome in bats.** Janicki/Tomasi, 2011
  Funding Source: Bat Conservation International

- **Are hibernating bats affected with WNS immunocompromised.** Moore/Kunz, 2008-2009
  Field-based study to assess various aspects of relative immune function
  Funding Source: National Speleological Society/Bat Conservation International

- **Exploring the Connection Between Arousal Patterns in Hibernating Bats and White Nose Syndrome.** Reeder/Frank/Britzke, 2008
  To determine if the hibernating patterns of bats are disrupted (which could lead to starvation) by monitoring little brown bats at affected sites, suspected sites, and control sites during 2008-2009.
  Funding Source: Northeast Regional Conservation Needs Grant

- **Studying Immune Competence in "healthy" bats and bats affected by White-Nose Syndrome.** Reeder, 2009
  Funding source: Bat Conservation International

- **Importance of Insect Chitin as an energy source for bats.** Dannelly/Chamberlain/Whitaker, Fall 2008
  Determine the significance of chitin utilization as a source of energy for hibernating bats and determine the bacterial flora present in WNS affected bats with emphasis on the makeup or lack of chitinase producing bacteria.
  Funding Source: Bat Conservation International

- **Fungal digestion of Chiropteran integument.** Pannkuk, 2010
  Quantify the amount of mechanical damage over time caused to bat integument by Gd.
  Funding Source: National Speleological Society

- **Assessing homeostatic balance in bats affected by WNS.** Cryan, 2010
  Funding Source: US Geologic Survey

- **The pre-white-nose syndrome mycological flora associated with cave hibernating bats in New Brunswick, Canada.** Vanderwolf/McAlpine/Forbes/Malloch
  2011 WNS Symposium Proceedings

- **Cryptic effects of geomycosis on bats in the Czech Republic.**
  Martinkova/Bandouchova/Bartonicka/Horacek/Kubatova/Pikula/Zima/Zukal
  2011 WNS Symposium Proceedings

- **Testing the dehydration hypothesis: Preliminary results from bats inoculated with Geomyces destructans.**
  Warnecke/Turner/Misra/Blehert/Cryan/Bollinger/Willis
  2011 WNS Symposium Proceedings

- **Environmental Contaminants and WNS.** Secord, 2009
  Funding Source: US Fish and Wildlife Service

Disease Surveillance

- **Acoustic monitoring of bat populations.** Herzog/Britzke, 2009
  Conduct long-term acoustic transects to evaluate changes in species composition and relative abundance.
  Funding Source: US Fish and Wildlife Service/Department of Defense/states/volunteers

- **Assessment of bat activity in Luzerne County, PA after WNS.** Whidden/Turner/Williams, 2010
  Acoustic monitoring at a wind turbine site for comparison of data pre-WNS and post-WNS.
  Funding source: National Speleological Society

- **Summer maternity bat colony – emergence counts and/or trapping surveys.** Butchkoski/Duchamp, 2009
  Conduct long-term maternity colony monitoring to investigate presence and health of, and effects of WNS on, summer maternity colonies. Coordination of regional database and volunteer hours to use as match for SWG (PA).
  Funding Source: US Fish and Wildlife Service/states/volunteers

- **Submission of *Myotis* bats to rabies labs.** Whitaker/ISU Center for North American Bat Research and Conservation, 2005
  Greatly increased numbers of *Myotis* bats were submitted in winter to the New York rabies lab during WNS and such increases could give an early warning to other states. The ISU center for North American Bat Research and Conservation is attempting to collect rabies information from other states, and if they are not presently identifying the bats, ISU is trying to stimulate them to do so.
  Funding Source: UNK

- **Information on weights of bats during hibernation period.** Whitaker/ISU Center for North American Bat Research and Conservation, 2008-2009
  Data on weights of hibernating bats were collected in the fall, spring, and winter, from Wyandotee Cave, Rays Cave, and Copperhead Cave (actually an abandoned coal mine), in Indiana.
  Funding Source: Indiana Department of Natural Resources

- **Effects of WNS on hibernating bat populations: applications of stochastic mathematical models.** Hallam/McCracken
  Develop a suite of models that 1) project dispersion of the fungal pathogen, 2) determine WNS effects on the life history stages of maternity and prehibernation that relate to starvation and dehydration during hibernation, and 3) investigate biological and chemical controls on the system that can be imposed to assuage WNS disease spread and modulate effects such as high rates of mortality.
  Funding Source: US Fish and Wildlife Service

- **Natural Micro-biome of Bats**. Hughes/Northup/Beucher, 2011
  Establish baseline microbiota data on two prominent western bat species that may be susceptible to WNS. The two major hypotheses are that there will be a diversity of natural microbiota on the healthy (non-WNS-exposed) bats, and that there will be no presence of Geomyces destructans.
  Funding Source: National Speleological Society

- **Non-invasive surveillance of bat hibernacula to investigate potential behavioral causes of mortality associated with WNS.** Cryan/Castle, 2009-2012
  Funding Source: US Geological Survey/ US Fish and Wildlife Service/National Park Service

- **Behavior of bats affected by WNS.** Brownlee/Reeder, 2010
  Observe WNS bats in natural hibernacula and in captivity using digital video recorders and use acoustic equipment to determine if bats are echolocating while hibernating.
  Funding Source: National Speleological Society

- **Hibernacula and post-hibernacula surveillance in Virginia for identifying WNS.** Reynolds, 2008-2009
  Funding Source: US Fish and Wildlife Service

- **Regional Surveillance of White Nose Syndrome**. Darling, 2009
  Track the spread and effects of WNS in VT, NH, and MA and participate in research conducted in New England. Collect sample material for genetic or lab analyses, respond to public inquiries and document and track unusual bat sightings, and report completed on winter hibernacula surveys, summer trapping and participation in other field activities.
  Funding Source: US Fish and Wildlife Service

- **WNS acoustic monitoring project at Grandpa's Knob, Rutland County, Vermont.** Stantec/Darling, 2009-2010
  Repeat acoustic surveys conducted for a proposed wind farm in the Lake Champlain area of VT to determine whether a trend can be detected as a result of elevated mortality levels due to WNS in VT and NY hibernacula.
  Funding Source: Stantec /Energy Company contributed proprietary information/ US Fish and Wildlife Service

- **A Novel BatCam for censusing maternity colonies of bats in regions affected by White-Nose Syndrome.** Kunz, 2009
  Funding Source: Bat Conservation International

- **A proposal to design an automated bat counter.** Herzog/Hicks, 2009
  Funding Source: Bat Conservation International

- **Fall swarm monitoring and tracking of Virginia bats affected by WNS.** Reynolds/Orndorff, 2009-2010
  Capture, assess, and band bats at both WNS positive and negative locations, band bats to facilitate tracking of WNS in individuals, and conduct surveillance of bats at WNS positive and negative sties in Virginia.
  Funding Source: National Speleological Society

- **Monitoring spatial and temporal patterns of wing damage from WNS and other factors in free-ranging bat populations: Uses and misuses of the wing damage index.** Reichard/Fuller/Kunz
  2011 WNS Symposium Proceedings

- **The impact of wing damage caused by white-nose syndrome in the little brown myotis**. Kunz/Fuller, 2011
  Funding Source: Bat Conservation International

- ***Geomyces destructans* spore retention on bats following hibernation from a confirmed WNS positive site: Preliminary findings and insights on the potential for bats to harbor and transmit WNS.** Turner/Reeder/ Keel/Valent/Gumbs/Kashmer
  2011 WNS Symposium Proceedings

- **Use of long wave ultra violet light as a potential screening tool to identify WNS.** Turner/Meteyer/Barton/ Gumbs/Blehert
  2011 WNS Symposium Proceedings

- **Continuous remote monitoring of bat activity at WNS-affected and unaffected sites.** Baker/Bayless/Redell/ Johnson/Slack/Pruitt/Armstrong
  2011 WNS Symposium Proceedings

- **Community ecology of bats on the maternity range: A comparison pre-and post-White-Nose Syndrome.** Kitchell/Wight
  2011 WNS Symposium Proceedings

- **Quantifying white noses: Patterns of visible fungus on photographed bats in New York.** O'Connor/Hicks/ Herzog/vonLinden
  2011 WNS Symposium Proceedings

- **Biometric and population changes associated with WNS Progression in Virginia: Preliminary results, Take II.** Reynolds/Orndorff/Hobson
  2011 WNS Symposium Proceedings

- **Bat activity patterns from two winters at White-Nose Syndrome infected hibernacula across eastern Pennsylvania.** Schirmacher/Britzke/Butchkoski/Arnett/Bayless
  2011 WNS Symposium Proceedings

- **White-Nose Syndrome and Illinois bat populations: Biology and monitoring.** Taylor/Yannarell/Miller/ Heske/Mateus-Pinilla/Merritt, 2011
  Establish a monitoring program for the rapid and early detection of the fungus, *G. destructans*, on bat specimens from around Illinois, characterize the background microbial load present in the fur of potential bat vectors of *G. destructans*, and characterize the establishment potential of *G. destructans* in Illinois cave environments.
  Funding Source: Illinois Dept of Natural Resources/US Fish and Wildlife Service, State WNS Grant

Conservation and Recovery

Population Monitoring

- **Development of a template for Region 3 states to use in WNS planning.** 2009-2010
  Assist Region 3 States in WNS planning.
  Funding Source: US Fish and Wildlife Service

- **Baseline data relevant to the WNS crisis: Analysis of survival, fecundity, and colony population trends of *Myotis* lucifugus in the northeastern US for the past 15 years.** Frick/Pollack/Reynolds/Kunz, 2009
  Funding Source: US Fish and Wildlife Service

- **Assessing the impact of WNS on the genetic viability of Indiana bats.** Amelon/Knudsen, 2009-2011
  Model population structure for Indiana bats to predict migration pathways, genetic loss, and risk of extinction, and compare genetic info of affected and non-affected individuals.
  Funding Source: US Fish and Wildlife Service

- **Genetic structure of Ozark big-eared bat populations and establishment of a noninvasive population-monitoring program (OK, AR).** Lee, 2011
  Funding Source: Bat Conservation International, Emergency Response Fund

- **A tool to assess WNS risk, prioritize surveillance, population monitoring, and management options across western landscapes.** Ormsbee/Rodhouse/Hobson
  2011 WNS Symposium Proceedings

Species Recovery

- **Population demographic models for the conservation of endangered Indiana bats at risk to white-nose syndrome.** Thogmartin, 2009-2010
  Allow the Service to be able to predict the consequences of alternative actions for the persistence and recovery of the Indiana bat, particularly in light of ongoing mortality due to WNS
  Funding Source: US Fish and Wildlife Service/US Geological Survey

- **Surge tunnels in quarries as potential hibernacula for bats.** Kurta
  2011 WNS Symposium Proceedings

- **Can bunkers be refuges from WNS for hibernating bats? Preliminary results from New Hampshire.**
  Brunkhurst/vonOettingen/Philibosian
  2011 WNS Symposium Proceedings

Captive Management

- **Establishing a security population of the Virginia Big Eared bat at the Smithsonian's National Zoological Park.**
  Songsasen/Wildt, 2009-2011
  Determine the feasibility of establishing a population of Virginia big-eared bats in captivity.
  Funding Source: US Fish and Wildlife Service

- **Experimental treatment of captive WNS affected little brown bats with vinegar wash.** Kershmer/Valent, 2009
  Detemine whether vinegar wash treatment or simple rehabilitative care will "cure" WNS affected bats.
  Funding Source: UNK

- **Analysis of alternative captive bat management strategies in response to WNS.** Parkin/Tawes/Pruitt/Rayman/Stark/Niver/vonOettingen/Douglas, Mackenzie/Coleman/Valenta
  2011 WNS Symposium Proceedings
  Funding Source: US Fish and Wildlife Service